

the men used the blade of an old reaping-hook to knock the Limpets off the rocks. However, we also discovered that, failing an instrument of that kind, they then took an oblong-shaped stone from the beach. The second day of our excavations at Caisteal-nan-Gillea we were puzzling ourselves as to what could be the use of the numerous oblong stones we met with among the shells, and mentioned the matter to our workman, who was accustomed to go to the fishing, and he seemed, just as a matter of course, to inform us that they were limpet-hammers. He assured us that he and his fisher-mates often took such stones from the beach when proceeding on a trip, and would retain the stone for collecting bait until the end of their fishing, when they would throw it away. Subsequent inquiries have only helped to confirm us in the opinion that the large oblong stones found at Caisteal-nan-Gillea are really limpet-hammers. We understand that similar stones have been found in the ancient kitchen-middens of other localities, and have proved a puzzle to antiquarians; but we think what we have stated will be found to be the real solution of the mystery.

DESCRIPTION OF PLATE IX.

All the bones are drawn of natural size.

Figs. 1-5. Dorsal vertebra shown in its different faces:—1, side view; 2, from above; 3, from below; 4, in front; 5, from behind.

Figs. 6-8. The entire left coracoid in three aspects:—6, exterior; 7, interior; 8, its antero-inner edge.

Fig. 9. Upper moiety of right coracoid, viewed from the front and inside.

Figs. 10-14. Different views of the right humerus:—10, posterior surface; 11, anterior surface; 12, external front edge; 13, superior condyloid extremity; 14, inferior condyloid extremity.

Fig. 15. Distal segment of left humerus.

Figs. 16-19. Different views of the distal end of the right tibia:—16, interior; 17, posterior; 18, anterior; and 19, the inferior face.

Descriptions of new or little-known *Comatulæ*.—I. & II.

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THE two following articles are the commencement of a series which I propose to offer to the Society from time to time, containing descriptions of *Comatulæ* that are either entirely new or but little known to zoologists. In all the principal museums of the Conti-

ment that I visited in the summer of 1880, I found great numbers of undescribed *Comatulæ* from very various localities. Some few of these I have worked out already*, while others are described in the following pages; and I hope in course of time to be able to take advantage of the courteous offers that have been made to me, and describe those that are as yet unnamed. They are very numerous, however; and when my descriptions of the hundred odd 'Challenger' species shall have been published, there will yet remain some fifty more, from the dredgings of the U.S. Coast Survey, to be worked out. Even after making allowance for the immense amount of local variation which occurs in the group, I should estimate it to contain at least four hundred species. Only thirty of these were described by Müller; and since his time less than twenty had been described by other naturalists up to the time when I began to work at the group, rather more than six years ago. Roughly speaking therefore, and apart from the 'Challenger' and 'Blake' collections, there remain some two hundred species yet to be described; so that a very long time must necessarily elapse before it is possible to make out a check-list of the *Comatulæ* like the admirable one of the Ophiurids which Mr. Lyman has published.

I have often wondered why the family has been so entirely neglected since the time of Müller; but the result is very advantageous to present workers in one point, viz., the very small amount of literature that has to be consulted. On the other hand, it is no easy task to draw up a satisfactory scheme of classification for four hundred species, more than nineteen-twentieths of which belong to but two genera. Only three species of *Pro-machocrinus* are known, and three of *Atelecrinus*. These last, together with the four species of the genus *Eudiocrinus*, are described in the following pages.

I. ON THE SPECIES OF ATELECRINUS AND EUDIOCRINUS†.

Genus ATELECRINUS, *P. H. Carpenter*, 1881‡.

Centrodorsal acorn-shaped, and bearing five vertical double rows of cirrus-sockets, those of each row alternating with one another and with the sockets of adjoining rows. They have horseshoe-shaped rims, the

* "The *Comatulæ* of the Leyden Museum," Notes from the Leyden Museum, vol. iii. pp. 173-217.

† Published by permission of the Lords Commissioners of the Treasury, and of Carlile P. Patterson, Superintendent of the U.S. Coast Survey.

‡ Bull. Mus. Comp. Zool. vol. ix. no. 4, p. 16.

arches of which are directed upwards, while the two ends slant downwards and outwards. Radials separated from the centrodorsal by a complete circlet of basals. The first six or more brachials bear no pinnules.

Remarks. Three species of this interesting genus are known, two from the Atlantic and one from the Pacific Ocean. One (*A. cubensis*) was dredged near Havana in 1868 by the U.S. Gulf-stream Expedition, though its singular characters were not then recognized. A second species (*A. balanoides*) was first obtained by the 'Challenger' (1873) in the Atlantic, somewhat to the south of Pernambuco. It was subsequently found off the north coast of Cuba by the U.S. steamer 'Blake' (1877-78), and again at four stations in the Caribbean Sea by the 'Blake' Expedition of 1878-79. The remaining species (*A. Wyvilli*) was dredged by the 'Challenger' in the neighbourhood of the Fiji Islands. Only one specimen was obtained, which, like the solitary example of *A. balanoides* from Pernambuco, is very much mutilated. The disk, however, is visible in both, which is not the case with any of the American specimens, though these last have more of the arms preserved.

From a morphological point of view, *Atelecrinus* is by far the most interesting of all the free Crinoids, as has been already pointed out in my preliminary 'Blake' report. The bathymetrical range, as at present known, varies from 291 to 450 fathoms; and it has a considerable geographical extension, occurring in the West Atlantic and Mid-Pacific, though not known as yet from any intermediate localities.

1. *ATELECRINUS BALANOIDES*, P. H. Carpenter, 1881.

Antedon cubensis, Pourt. (*pars*) Bull. Mus. Comp. Zool. vol. v. no. 9, p. 214.

Atelecrinus balanoides, P. H. Carpenter, Bull. Mus. Comp. Zool. vol. ix. no. 4, p. 16.

Centrodorsal acorn-shaped, reaching 5 mm. high by nearly $3\frac{1}{2}$ mm. in diameter. It bears five vertical double rows of cirrus-sockets, the upper ends of which are separated by more or less distinct interrarial ridges. Four to six sockets in each row, the dorsal pole, though rough, being free from functional sockets. The ends of their horseshoe-shaped rims slant downwards and outwards, but are much more prominent in some individuals than in others.

The cirri have three or four quite short, almost triangular basal joints. The next joint is twice as long as wide, and its successors

are much elongated, reaching $2\frac{1}{2}$ mm., with a slight tendency to overlap one another on the ventral side of the cirrus. There are probably about 35 joints, the length much exceeding the breadth till the penultimate, which is followed by a very small terminal claw. The last six joints taper rapidly.

The basal ring is a very thin plate rising at the interradian angles into triangular elevations, which are produced slightly outwards and rest upon the upper ends of the interradian ridges of the centro-dorsal. First radials broad and tolerably flat, their size varying with the age of the individual. Second radials more arched, oblong, and quite free laterally, their breadth in the adult being one and a half times their length. Axillaries pentagonal, twice the length of the second radials, into which they have a slight backward projection. Their width is about equal to their length, but their proportions and also those of the second radials vary slightly in different individuals.

First brachials well separated laterally, with their inner sides shorter than the more rounded outer ones. Second brachials irregularly quadrate, projecting slightly backwards into the first. The following joints have markedly unequal sides. Except in the syzygial joints the length is at first less than the breadth, but gradually becomes more equal, and exceeds it after the fifteenth joint. Terminal joints relatively longer and more equal-sided. Arm-bases smooth, but the middle and later joints overlap slightly.

The first syzygium on the third brachial. The following syzygia at intervals of from one to six, usually of two or three joints.

First pinnule nearly always on the 12th brachial, and consisting of about a dozen elongated joints. The following ones increase in size and in the number of joints, decreasing again towards the arm-ends. The lower joints of the middle and later pinnules bear irregular spinous processes on their dorsal edges.

Mouth excentric, and surrounded by a large peristome. Immediately behind this is the anal tube, which is thus nearly central. Disk 6 mm. in diameter. In the 'Challenger' specimen a few minute calcareous granules are visible on its ventral surface, and also on its sides between the rays. The 'Blake' specimens are more naked. The brachial ambulacra lie close down upon and between the muscular bundles, and have a few scattered sacculi at their sides. Colour of skeleton white or brownish white.

1873. H.M.S. 'Challenger.' Station 122. Lat. $9^{\circ} 5' S.$ to $9^{\circ} 10' S.$; Long. $34^{\circ} 49' W.$ to $34^{\circ} 53' W.$ Depth 350 fms. Mud. One specimen.
- 1877-78. U.S. C.S. str. 'Blake.' Station 43. Lat. $24^{\circ} 8' N.$; Long. $82^{\circ} 51' W.$ Depth 339 fms. One specimen.
- 1878-79. Ditto. Station 150. Between St. Kitts and Nevis. Depth $373\frac{1}{2}$ fms. Ooze and coarse fragments of pumice. Two specimens, one of which is young.
- Ditto. Station 151. Off Nevis. Depth 356 fms. Two specimens.
- Ditto. Station 222. Off St. Lucia. Depth 422 fms. One specimen.
- Ditto. Station 260. Off Granada. Depth 291 fms. Fine grey ooze. Two specimens.

The nine individuals of this species which I have examined all agree very well in their general characters, but differ considerably in the relative proportions of the two outer radials and of the lowest brachials. In all of them which have enough of the arms preserved the first pinnule is on the twelfth brachial, except in one arm of one individual, in which the tenth joint bears the first pinnule.

2. ATELECRINUS CUBENSIS, *Pourt.*, sp.

Antedon cubensis, *Pourt.* (*pars*) *Bull. Mus. Comp. Zool.* vol. i. no. 11, p. 356; and vol. v. no. 9, p. 214.

Atelecrinus cubensis, *P. H. Carpenter*, *Bull. Mus. Comp. Zool.* vol. ix. no. 4, p. 16.

Description of an Individual.—Centrodorsal acorn-shaped, 2 mm. high and nearly 2 mm. wide, covered by five double rows of closely-set cirrus-sockets, which extend almost to the dorsal pole. Usually four sockets in each row, with very strongly marked horseshoe-shaped rims, the ends of which stand out prominently, so as to give the surface of the plate a very rough appearance. Its uppermost portion bears no sockets or only very rudimentary ones, and is produced at the interradian angles into five prominent ridge-like processes, which disappear below between the rows of sockets. The basal ring is pentagonal, with its angles so produced as to rest on the upper ends of these ridges. It is of nearly uniform height ($\cdot 5$ mm.) all round the calyx, rising very slightly at the interradian angles.

First radials short, broad, and considerably arched. Second radials twice their length, and rather wider than long, with the distal edges incised to receive the proximal angles of the quadrate axillaries, which are also wider than long.

First brachials well separated laterally, with the inner sides much shorter than the outer ones, which sometimes project

slightly beyond the edges of the axillaries. The distal edge is much incised to receive the strong backward projection of the quadrate second brachial. The following joints have markedly unequal sides, the third (or occasionally the fourth) and the fifth or sixth being syzygies.

Disk naked. Mouth slightly excentric, with the anal tube just behind it. Brachial ambulacra close down upon and between the muscular bundles. Skeleton brownish white.

Off Cojima, near Havana. Depth 450 fms. One specimen.

Although this species was discovered some four years earlier than *At. balanoides*, I have thought it best to take the latter as the type species of the genus, as it is represented by more abundant and better preserved material, the single example of *At. cubensis* having lost all its cirri and all the arms above the first six or seven joints. The specific name was given to it by Pourtales, who referred it provisionally to the type of *Antedon cubensis*, which was obtained in the same dredging. The chief difference between it and *Atelecrinus balanoides* is in the uniform height of the basal pentagon, and the stronger backward projection of the third radials and second brachials into the preceding joints.

3. ATELECRINUS WYVILLI*, n. sp.

Description of an Individual.—Centrodorsal acorn-shaped, 4 mm. high by 3 mm. wide. The double rows of cirrus-sockets are well separated from one another by intervening spaces, and do not reach the dorsal pole. Four, or rarely five, sockets in each row, the ends of which stand out prominently and give a serrate appearance to the lateral edge of the plate. The upper portion is uniformly smooth, without any interrarial ridges; but the edge is marked by five slight incisions situated interradi ally.

The basals are nearly uniform in height throughout their whole width, but are somewhat arched in form. The apex of each arch is interrarial, and the interval between it and the notched edge of the centrodorsal below is only occupied by perisome. Hence the basal ring is really only in contact with the centrodorsal at its five lowest points, *i. e.* at the interbasal sutures, immediately beneath the middle of each first radial. The latter have exceedingly high muscle-plates projecting inwards; but their dorsal surface is barely half as long as that of the second radials. These are nearly square, but deeply incised to receive the strong back-

* I dedicate this very interesting species to the memory of Sir Wyville Thomson.

ward projections of the axillaries, which are roughly rhombic and slightly wider than long.

First brachials well separated laterally, with the inner sides much shorter than the outer ones, and the distal edges much incised to receive the strong backward projections of the quadrate second brachials. The following joints have markedly unequal sides with syzygies on the third or fourth, and again on the fifth, sixth, or seventh brachials.

Disk almost naked, 4 mm. diameter. Mouth excentric, and surrounded by a large peristome, immediately behind which is the nearly central anal tube. Brachial ambulacra close down upon and between the muscular bundles. Skeleton light brownish white.

H.M.S. 'Challenger.' 1874. Station 174. Lat. $19^{\circ} 10' S.$; Long. $178^{\circ} 10' E.$ Depth 225, 610, and 210 fms. *Globigerina*-ooze. One specimen.

Atelecrinus Wyvilli differs from the two forms already described in the greater squareness of the second radials, and in the curious relation of the basals to the centrodorsal. They are of uniform height, as in *At. cubensis*, but are not in contact with the centrodorsal at the interradian angles of the calyx, being separated from it on the exterior of the calyx by a gap which is filled up by peristome. Apart from its purely morphological importance, this Pacific species is also interesting as showing the wide distribution of the genus.

EUDIOCRINUS, gen. nov.

1868. *Ophiocrinus*, C. Semper, *Wieg. Archiv*, Jahrg. xxxiv. p. 68.

1869. *Comatula* (*Ophiocrinus*), P. de Loriol, *Denkschr. d. allg. schweiz. Gesellsch. f. d. ges. Naturw.* Bd. xxiii. (Zurich, 1869), p. 57.

1879. *Ophiocrinus*, P. H. Carpenter, *Proc. Roy. Soc.* No. 194, 1879, p. 385.

1879. *Ophiocrinus*, P. de Loriol, *Monogr. des Crinoïdes fossiles de la Suisse* (Geneva, 1877-79), p. 277.

Centrodorsal and first radials like those of *Antedon*; but the radials bear the brachials directly without the intervention of axillaries, so that there are only five undivided arms. Mouth central. Sacculi abundant, scanty, or absent altogether.

The genus *Ophiocrinus* was established by Prof. Semper in 1868 for an elegant little *Comatula* with five undivided rays, which he had discovered in the Philippine Islands; and in the following year a fossil species was described by De Loriol from the Neocomian of Switzerland. The generic value of the type was

doubted by Schlüter*; and I have myself had some hesitation in regarding it as equivalent to *Antedon*, *Actinometra*, and *Promachocrinus* †. For there is no definite character, except the simplicity of the rays, which can separate *Ophiocrinus* from the ordinary ten-armed *Antedon*; and in one of the three known species of the ten-rayed *Promachocrinus* the rays divide, so as to form twenty arms; while in the two others there are ten undivided rays. But this character alone would hardly justify the separation of the simpler type of *Promachocrinus* from the twenty-armed form; while I have an abnormal specimen of an *Antedon* with only nine arms, owing to one of the rays not dividing, which is the case with all the rays of *Ophiocrinus*.

Nevertheless it sometimes happens that a character which is only of specific value in one type may be of generic value in another; and as four recent species of *Ophiocrinus* are known which range from Japan into the South Pacific Ocean (lat. 37° S.), together with the fossil from the Neocomian of Switzerland, the simplicity of the rays appears to be a character of some morphological importance; and I am therefore disposed to admit the generic value which was originally assigned to it by Semper. Unfortunately, however, this type cannot continue to bear the name by which it has been hitherto known. For Salter, fifteen years previously to Semper's description of *Ophiocrinus*, had designated by the same generic name an obscure Crinoid from the Devonian of South Africa; and the confusion thus existing was increased by the posthumous publication, in 1878, of the late Prof. Angelin's 'Iconographia of the Swedish Silurian Crinoids,' in which the name *Ophiocrinus* is connected with a third and totally distinct type.

Prof. Semper's genus being thus preoccupied, I propose to call the type *Eudiocrinus* (εὔδιος, calm), in allusion to the fact that all the recent species of it which are known to science are limited to the Pacific Ocean.

In its central mouth and in the structure of its calyx *Eudiocrinus* is essentially an *Antedon*. But the sacculi which are usually so abundant at the sides of the ambulacra of this genus are not so constant in *Eudiocrinus*. *E. indivisus* has numbers of them, while they are scanty in *E. varians*, and altogether

* "Ueber einige astylide Crinoiden," Zeitschr. der deutsch. geolog. Gesellsch. Jahrg. 1878, p. 40.

† Quart. Journ. Geol. Soc. vol. xxxvi. p. 41.

absent in the two remaining species, which I have never found to be the case in *Antedon*, though I have examined over one hundred species of this genus.

Genus EUDIOCRINUS.

- I. First two brachials united by syzygy. First pinnule on the second brachial 1. *indivisus*, Semper.
- II. First two brachials united by a ligamentous articulation.
 - 1. First pinnule on second brachial 2. *varians*, n. sp.
 - 2. First pinnule on fourth brachial.
 - (i) Disk plated. First brachials nearly oblong 3. *Semper*, n. sp.
 - (ii) Disk naked. First brachials trapezoidal 4. *japonicus*, n. sp.

1. EUDIOCRINUS INDIVISUS, *Semper*, sp.

Ophiocrinus indivisus, *Semper*, *Wieg. Archiv*, Jahrg. xxxiv. p. 68.

Description of an Individual.—Centrodorsal small, convex, and bearing about twenty cirri in two marginal rows, the dorsal pole being free from them. Cirri 9 mm. long, of about twenty joints; the third square, or a trifle longer than wide; the fifth is the longest, and the following ones nearly all longer than wide, and overlapping on the dorsal side; penultimate with an opposing spine.

Radials partially visible, and about one third the length of the compound joint formed by the syzygial union of the first two brachials, the second of which bears a pinnule on the left side. Third brachial short, oblong, and bears no pinnule. The next four or five joints nearly oblong, slightly shorter on one side than on the other, which is not so long as the breadth and bears a pinnule. The tenth and following joints have more markedly unequal sides, the longer of which is longer than the breadth. About 120 arm-joints, the middle ones nearly square, and the terminal joints elongated.

Second syzygy on the fifth brachial, the next on the ninth, and the next on the thirteenth (once on the twelfth) brachial; after this an interval of two joints between successive syzygia.

First pinnule (on second brachial) quite small, consisting of about a dozen short joints, the basal ones of which are rather broad. Second pinnule (on fourth brachial) somewhat longer and stouter; the third and fourth very much so, with longer and more massive joints. The next three or four pinnules on either side gradually decrease in size; and the following ones increase

again, the terminal ones being very long and slender, so as to give the arms a very feathery appearance.

Disk lost. Sacculi tolerably close on the arms, but much larger and more closely set at the sides of the pinnule-ambulacra, which have only the very slightest trace of any superficial limestone deposits.

Colour of skeleton brownish white.

Spread 15 centim. Disk must have been somewhat less than 3 mm. diameter.

Locality. Pandanon, near Bohol, Philippine Islands. 30 fms.

The unique example of this species, which was dredged by Prof. Semper at Pandanon, is now in the collection of Dr. Carpenter. Prof. Semper's description of the type is an excellent one; but I have ventured on another in order to add in some points which were not noticed by him, and are of interest in the comparison of *Eudiocrinus* with other *Comatulæ*. It is a very slender and graceful [little species, differing altogether in appearance from those dredged by the 'Challenger' which are described below.

2. EUDIOCRINUS VARIANS, n. sp.

Centrodorsal low, nearly hemispherical, bearing about twenty cirri in two rows which leave the dorsal pole free. Two forms of cirrus occur in the same individual.—(1) With the three basal joints as long or a trifle longer than wide; the fourth considerably longer, and the fifth and next following ones still more so, reaching 3 mm. in length. Terminal joints unknown. (2) Cirrus-joints quite short, the first six about square, and the next six a trifle longer than wide. Remainder unknown. Radials partially visible. First brachials nearly oblong, inclined to be trapezoidal, with small lateral processes which are the edges of the muscle-plates for articulation with the radials. Second brachials also nearly oblong, with traces of a backward process into the preceding joint, a pinnule on the right, and a small process on the left side. The following joints have unequal sides, with a pinnule on the shorter, and a large wing-shaped process on the longer, which ceases on the sixth, or may go on to the eighth joint. Succeeding joints quadrate and unequal-sided, with the pinnule on the longer side. The twelfth and following joints are distinctly longer than wide.

Syzygia on the fourth and eighth or ninth brachials; then an interval of 2-5 joints between successive syzygia.

The first six pinnules have wide basal joints, the fourth and

two following ones being more or less expanded towards the dorsal side. This is most marked in the lowest pinnules of the larger specimen. The later pinnule-joints are elongated, but very much more slender in the small specimen than in the larger one. The lower pinnules appear to be the longer, containing more numerous, though shorter joints. That on the fourth brachial in the larger specimen is almost 12 mm. long, and consists of twenty-five joints.

Disk 5 mm. wide. It bears numerous calcareous nodules, but the brachial ambulacra only have delicate rods and networks of limestone at their sides. Sacculi are present, though small, inconspicuous, and few in number. Skeleton white.

The smaller specimen is $3\frac{1}{5}$ mm., and the larger $4\frac{1}{2}$ mm. across the centrodorsal.

H.M.S. 'Challenger.' 1874. Station 205. Lat. $16^{\circ} 42' N.$; Long. $119^{\circ} 22' E.$ Depth 1050 fms. Grey ooze.

This is a very singular species. The two mutilated individuals described above resemble one another very closely in the characters of the calyx and arms, while the cirri and pinnules vary considerably. In the smaller one I can find no certain trace of any but the long-jointed cirri like those of *E. Semperi* and *E. japonicus*. But in the larger form, which retains the bases of two, if not more, of these, the majority of the cirri consist of numerous short joints but little longer than wide.

In the smaller form, again, most of the pinnules are quite slender and delicate, with somewhat glassy joints which are twice, or more than twice, as long as wide. But in the larger one they are usually considerably stouter and more massive, though one or two of the lowest pinnules are much more slender than their fellows, and somewhat resemble those of the smaller individual. The variation in these pinnule characters and the striking dimorphism of the cirri are the more remarkable, as in most *Comatulæ* the peculiarities of these organs are of considerable value in the distinction of species.

3. EUDIOCRINUS SEMPERI, n. sp.

Centrodorsal small, nearly hemispherical, or somewhat flattened, thickly covered with cirrus-sockets except at the dorsal pole. These have strongly marked articular rims around the opening of the central canal, and are from twenty to thirty in number. Cirri probably 30 mm. long and tapering, of 21+

joints ; the first three quite short, the fourth more than twice as long as wide, and the next four the longest, sometimes exceeding 2 mm. The following ones diminish slowly in size, but exhibit no traces of any dorsal spines.

Radials partially visible. First brachials nearly oblong, widening slightly, and then narrowing a little. Second brachials quadrate, and appearing in a side view of the specimen to project strongly backwards into the first brachials, as the surfaces of both joints rise towards the middle of their line of junction. The following joints have unequal sides, the fourth having a syzygy and bearing a pinnule on the shorter side. In one specimen the pinnule is on the right side in all but the right anterior ray ; and in the other in all but the two antero-lateral rays. The seventh joint is more oblong ; and the eighth and following joints become more distinctly unequal-sided, the breadth being somewhat less than the length of the longer side which bears the pinnule. Further out on the arms the length gradually increases in proportion to the breadth, and the joints become more and more cylindrical.

The second syzygy is on the seventh, eighth, or ninth brachial ; and the later syzygial intervals vary from one to four joints.

The lower pinnules are all about equal in length, and consist of some twenty joints. Except in the first four or five pinnules all but the lowest joints are twice as long as broad, or slightly longer, and more transparent and glassy than the cirrus-joints. Ovaries short, not extending over more than three or four joints. Towards the arm-ends the pinnules gradually decrease in length and in number of joints.

Mouth central. Disk and arm-bases rather closely plated, but the brachial ambulacra merely have irregular rods and networks of limestone at their sides. They lie close down between the muscles and show no traces of sacculi. Skeleton white.

Disk 5 mm. in diameter. Radial pentagon 4 mm. Spread probably about 15 cm.

H.M.S. 'Challenger,' 1874. Station 164. Lat. $34^{\circ} 8' S.$; Long. $152^{\circ} 0' E.$ Depth 950 fms. Grey ooze. One specimen.

Station 169. Lat. $37^{\circ} 34' S.$; Long. $179^{\circ} 22' E.$ Depth 700 fms. Grey ooze. Two specimens.

I have named this species after Prof. Semper of Würzburg, to whom we owe the discovery during his residence in the Philippine Islands of the type species of *Eudiocrinus* (*E. indivisus*).

The absence of pinnules on the second and third brachials distinguishes it from this last and also from *E. varians*. Although *E. indivisus* is richly provided with large sacculi at the sides of the brachial ambulaera, they are smaller and more scanty in *E. varians* than in *Atelecrinus* or in any *Antedon* I know; while they are absent altogether in *E. Semperi* and in the closely allied *E. japonicus*. These organs occur in all the other genera of *Comatulæ* which have a central or a subcentral mouth, viz. *Atelecrinus*, *Antedon*, and *Promachocrinus*; while they are also found in nearly all the genera of Stalked Crinoids which have the mouth in this position, viz. *Rhizocrinus*, *Pentacrinus*, and *Bathycrinus*. I have no information as to their presence or absence in *Ilycrinus*, but I have failed to find them in *Holopus*.

Eudiocrinus Semperi, like other *Comatulæ*, exhibits a certain amount of local variation. All three specimens were obtained in a very mutilated condition, hardly any thing remaining of one of them but the calyx and the bases of three arms. But sufficient remains of the other two to indicate a considerable amount of flexibility in some of their characters. That from the lesser depth (Station 169) is the larger of the two, and its disk bears larger and more numerous plates; while there are fewer cirri on the centrodorsal, and the pinnule-joints are somewhat shorter and less glassy than those of the individual from Station 164. In the former also, both the antero-lateral rays have the first pinnule on the left side; while in the latter this is only the case in the right anterior ray.

4. EUDIOCRINUS JAPONICUS, n. sp.

Centrodorsal relatively large, conical, and covered except at the dorsal pole by 40–50 cirrus-sockets, with a well-marked articular rim around the opening of the central canal. Cirri more than 35 mm. long, tapering, and consisting of 27+ joints; the first three are quite short, the fourth a good deal longer than wide, and the next four the longest, but scarcely reaching 2 mm.; the following ones diminish slowly in size, but exhibit no traces of any dorsal spine.

Radials just visible. First brachials trapezoidal, the proximal edge being wider than the distal one, where the union with the second brachial is by a ligamentous articulation. The proximal faces are produced into large muscle-plates for articulation with the radials. The second brachials, as seen from below, are also trapezoidal, being narrower along their proximal edges. The

surfaces of both joints rise towards the middle line of their junction, so that in a side view of the specimen the second seem to have strong backward projections into the first brachials. The next four or five joints have unequal sides, the fourth being a syzygy and bearing a pinnule on its shorter side. In the only specimen with all the arm-bases preserved, one of them has the first pinnule on the left side. The fifth and one or two following joints also have the pinnule on the shorter side. The next is more oblong, and its successor again a syzygy, with the pinnule on its longer side. The succeeding joints have still more markedly unequal sides, the breadth being about equal to the length of the longer side. After the second syzygy there is an interval of four or five joints between successive syzygia.

The lowest pinnules are apparently tolerably equal, consisting of some twenty stout joints, of which only a few middle ones are longer than wide. Beyond the eighth brachial, the pinnule-joints become relatively longer and thinner and the pinnules more slender. Ovaries short, not extending over more than three or four joints.

Mouth central or subcentral. Disk naked, 7 mm. in diameter. Brachial ambulacra close down between the muscles, with a few supporting rods and networks of limestone, but no traces of sacculi. Skeleton white.

Diameter of radial pentagon $4\frac{1}{2}$ mm.

H.M.S. 'Challenger,' 1874. Station 235. Lat. $34^{\circ} 7' N.$; Long. $138^{\circ} 0' E.$ Depth 565 fms. Mud. Three much mutilated specimens.

It is with some hesitation that I have separated this species from the preceding one. It is altogether larger and more massive than *E. Semperi*, with a larger and more distinctly conical centrodorsal and more numerous cirri. The first brachials have larger muscle-plates for articulation with the radials and are more trapezoidal in outline, so that the arm-base is distinctly narrowed at the junction of its first two joints. The fourth and next following joints are relatively shorter and more oblong than in *E. Semperi*, though the general proportions of the remaining arm-joints seem much the same in the two cases. The position of the first pinnule, *i. e.* whether on the right or left side of the arm, does not appear to be a character of much importance, as the two examples of *E. Semperi* do not agree in this respect. One of them has the first pinnule on the left side in two arms, but the other only in one, as in the solitary specimen of *E. japonicus* which has the arm-bases at all well preserved.

There are some specimens of *Eudiocrinus* in the University Museum at Berlin, which were kindly shown to me by Dr. Hilgendorf, who had collected them in Japan. I think that they are probably identical with the type just described. They have rather fewer cirrus-joints, and the junctions of the first eight brachials are distinctly tubercular. The tubercle between the first pair is in the middle line, and those between the following joints lie alternately on either side of the arm. The three 'Challenger' examples, however, show no traces of these tubercles, with the exception of the median one, which is far less marked than in the Berlin specimens.

II. THE COMATULÆ OF THE HAMBURG MUSEUM.

When I visited my friend Dr. H. Ludwig (now professor at Giessen) at Bremen in August 1880, I found that the Echinoderm collection of the Hamburg Museum was in his hands for the purpose of description. It included several fine *Comatulæ*, to examine which I was then on my way to Hamburg; and Dr. Ludwig most kindly offered to ask permission from the directorate of the museum to transfer them to me for examination and description. This was readily granted by Dr. H. Bolau, the chief director, and by Dr. Karl Krapelin, who has especial charge of the Echinoderms, and was good enough to forward to me four dry specimens that had not been sent to Dr. Ludwig. To all these gentlemen, therefore, my sincere thanks are due for their courteous readiness to facilitate my work.

Apart from the ordinary European *Comatula*, the museum contains nine species of *Antedon* and seven of *Actinometra*. Eight species of the former genus and one of the latter are new to science, while *Act. robusta*, Lützk., though long known in collections, is here described for the first time; and the occurrence of a well-preserved spirit-specimen of *Act. solaris*, Müll., has enabled me to add somewhat to our knowledge of this important type.

The mutual relations of the various species referred to in the following pages are shown in the accompanying keys.

Genus ANTEDON, *de Frem.*

A. Ten arms.

- a.* Arm-joints compressed and keeled 1. *carinata*, Lam.
- b.* Arms not keeled. Lower pinnules smooth-jointed and tolerably equal 2. *levipinna*.

- B. Rays divide three times; each division of two joints, the axillary without a syzygy.
- a. The fourth and fifth brachials bear large tolerably equal pinnules 3. *æquipinna*.
 - b. Pinnule on fourth brachial much larger than those on the fifth and sixth. 4. *imparipinna*.
- C. Rays divide three times. First division of three joints, the axillary with a syzygy; second of two joints, the axillary without a syzygy.
- a. About thirty cirrus-joints. Lower pinnules unlike on inner and outer arms of each ray.
 - 1. Bases of the rays almost smooth. Middle and outer parts of the arms serrate. 5. *variipinna*.
 - 2. First radials crenulate. Rays tubercular at the base. Middle and outer parts of the arms smooth 6. *crenulata*.
 - b. Fifty or more cirrus-joints. Lower pinnules similar on all the arms.
 - 1. Terminal cirrus-joints smooth. 7. *acuticirra*.
 - 2. Terminal cirrus-joints have dorsal tubercles. 8. *Ludovici*.
- D. Rays divide three times; each division of three joints, the axillary with a syzygy.
- a. Cirri long and stout, with imperfect claw and smooth terminal joints 9. *bipartipinna*.

1. *ANTEDON CARINATA*, Lam., sp.*

The museum contains eight examples of this species, including two dry ones from Mauritius, the original home of the type. They are remarkable for the very slight carination of the dorsal surface of the arms. Had Lamarek's original specimens been like these, he would assuredly never have given them the specific name "*carinata*."

There are also two examples (*sine patria*) which have as many as thirty cirri, a larger number than is found on Mauritius specimens; while the pinnules are considerably stouter and more fleshy than in the type, the lower ones especially having broader basal joints.

The remaining four specimens of this widely distributed species are from Java, a new locality for it. They are more like the Mauritius type, having only from twenty to twenty-five cirri and more slender pinnules; but the later pinnules are much less stiff than usual, so that the arm-ends have a more feathery appearance than is the case in the type.

2. *ANTEDON LEVIPINNA*, n. sp.

Description of an Individual.—Centrodorsal a thick convex disk,

* The literature of this species will be found on pp. 179, 180 of 'Notes from the Leyden Museum,' vol. iii.

bearing seventeen marginal cirri. These consist of 25-35 thick joints, the first five or six of which are short and broad, and their immediate successors about square. A faint dorsal spine appears about the tenth joint and increases in size rather rapidly, the joints also shortening somewhat. In the later joints the spine is slightly smaller and projects forwards rather less strongly, but it is larger on the penultimate than on any previous joint.

Ten arms, the rays dividing only once, but remaining close to one another. Three radials visible. The first are longer at the sides than in the centre, and the second broadly hexagonal, partly united laterally. Both they and the axillaries rise towards the middle of their line of junction, which stands up as a prominent tubercle. Axillaries almost triangular and but little longer than the second radials. First brachials widely pentagonal, partly united by their inner ends, which are somewhat shorter than the outer ones. Second brachials irregularly quadrate, their inner ends projecting beyond the edges of the preceding joints. The outer sides of both joints are somewhat flattened laterally, and they rise steeply towards their line of junction just as the two outer radials do. Third brachial short and oblong, a syzygy. The next few joints also short, rounded and nearly oblong, with slight backward projections alternately from the inner and outer sides of their proximal edges. The following ones short and sharply wedge-shaped; at first considerably wider than long, but narrowing rather quickly and also commencing to overlap, so that the middle and later joints are almost saucer-shaped.

Syzygia on the third and eighth brachials; then an interval of 6-12, usually 9 or 10, joints between successive syzygia.

None of the pinnules are specially distinguished. The first, on the second brachial, is slender, consisting of about fifteen smooth cylindrical joints. The next (on third brachial) is shorter and more slender; and the next about as long as the first, but stouter, having thicker joints all very smooth. The basal joints of the next two pairs are still rather thick, after which they decrease in size; and the pinnules increase very slowly in length, never becoming specially long, and consisting of smooth cylindrical joints. Disk about 6 mm. in diameter, almost concealed; anal tube plated.

Colour light brown, with purplish bands. Sacculi closely set on the pinnule-ambulacra. Spread 15 centim.

One specimen from Canton.

Remarks.—The tubercular character of the radials and the

equality in length of the smooth lower pinnules on the outside of the arm distinguish this species from any hitherto described.

3. *ANTEDON EQUIPINNA*, n. sp.

Description of an Individual.—Centrodorsal discoidal, bearing about forty cirri in a single or partially double marginal row, which leaves the flat dorsal surface free. Cirri of 24–28 tolerably uniform, smooth, thick joints, of which the sixth is about square, while those immediately following it may be a trifle longer than broad; the penultimate has a small blunt spine, a trace of which is sometimes visible on the preceding joint.

First radials not visible; second short and wide, nearly oblong, slightly united laterally. Axillaries less than twice their length, pentagonal, with wide distal angles.

43 arms of 160 smooth joints, the rays dividing three or rarely four times. Each division of two joints, the first closely united to their fellows and the axillary not a syzygy. First brachials almost rhomboidal, relatively long and narrow and closely united to their fellows. Second joints much shorter and nearly oblong, slightly longer on the outer than on the inner side. Third (a syzygy) and the next four joints transversely oblong, with traces of forward and backward projections alternately on opposite sides. The following ones longer, though still short and sharply wedge-shaped, considerably wider than long; becoming blunter towards the middle of the arms and squarer towards the ends.

First syzygy on the third brachial, and the next between 9 and 20, usually about 16; after which the syzygial interval is 6–12, usually 8 or 9, joints.

First pair of pinnules, on second and third brachials, short, slender, and tolerably equal, of about 20 longish joints. The next pair twice their length (13 mm.), much stouter, and rather stiff. The next pinnule (on 6th brachial) somewhat smaller than the first one, and the next four continue to decrease. The remaining pinnules gradually increase in length, becoming slender and delicate in the outer parts of the arms, but not longer than the second pair.

Disk naked and somewhat incised, 20 mm. in diameter, and coloured dark grey. Skeleton an alternation of purplish red and white, with alternating double rows of dark spots on the white parts.

Brachial ambulacra close down between the muscles; those of the pinnules more fleshy, with closely set sacculi.

One specimen *sine patria*. Spread about 20 centim.

Remarks.—This species comes very near to *Ant. lævicirra* of the Leyden Museum. It differs, however, in having more numerous cirri, the second radials less closely united, and shorter axillaries. The lower and middle arm-joints are relatively shorter, and the two pinnules of the second pair (on 4 and 5 brachials) are more nearly equal than in *A. lævicirra*; while the terminal pinnules are much more delicate and less clothed with perisome.

The colouring is not unlike that of *Ant. bimaculata*, also in the Leyden collection; but in this species the third pinnule on the outside of the arm (on 6th br.) is larger than the second, while the reverse is the case in *Ant. æquipinna*.

4. ANTEDON IMPARIPINNA, n. sp.

Description of an Individual.—Centrodorsal a convex disk with a slightly hollowed dorsal pole and two or three rows of cirri on its sloping sides. 35 cirri of 25–28 smooth thick joints, of which the sixth is about square and the following ones longer than broad, becoming shorter again towards the end; the penultimate bears a very faint blunt spine.

First radials partially visible at some of the angles of the calyx; the second, widely hexagonal, partly united laterally. Axillaries not one and a half times their length, pentagonal, with wide distal angles. The lines of junction of the axillaries with the joints above and below them are narrower than the joints themselves, so as to give the sides of the rays a somewhat jagged appearance.

38 arms, the rays dividing thrice; each division of two joints, the first almost completely united laterally and the axillary not a syzygy. First brachials almost rhomboidal, relatively long and narrow, closely united to their fellows. Second joints shorter and more wedge-shaped, longer on the outer than on the inner side. Third joint a syzygy and oblong. The next four nearly so, but shorter. The following ones longer, though still short, smooth, and sharply wedge-shaped, considerably wider than long. About the middle of the arm they become blunter, with forward projections alternately on opposite sides, and are squarer towards the ends.

The first syzygy is on the third brachial, and the next usually from 12–14, after which the syzygial interval is from 8–10 joints.

The second brachial bears a moderately long pinnule, tapering away rapidly after the basal joints, which are relatively rather large. That on the third brachial is considerably smaller, but

the next one (on 4th br.) is unusually large and massive, consisting of 30 stout joints and reaching 15 mm. in length. The next two are smaller again and about equal to the first pinnule; the following pair still smaller, after which the length gradually increases, though it never much exceeds that of the first pinnule.

Disk invisible; diameter across the circle of distichal axillaries 13 mm. Colour brownish white, with traces of darker spots. Sacculi rather scanty on the pinnule-ambulacra. Spread probably about 15 centim.

One specimen *sine patria*.

Remarks.—This species is distinguished from the previous one by the great disproportion in the sizes of the third and fourth pinnules. It is much more marked than in *Ant. laevicirra*, which also differs in having more uniform cirrus-joints, a longer interval between the first two syzygia, and less marked forward projections on the arm-joints.

5. ANTEDON VARIIPINNA, n. sp.

Description of an Individual.—Centrodorsal a moderately thick convex disk, bearing about 25 cirri in a double row. These have about 30 tolerably uniform joints, of which the fifth is about square, the next two or three a trifle longer than wide, and the following ones shorter again. From about the twelfth onwards the joints have rather sharp dorsal spines, that on the penultimate being considerably larger than its predecessors. First radials partially visible; the second oblong, short and wide, partly united laterally. Axillaries also short, but little longer than the preceding joints, and pentagonal with very open angles.

23 arms, some rays dividing thrice: primary arms of three joints with somewhat uneven edges, the last being axillary with a syzygy. Secondary arms of two joints, the axillary not a syzygy. The first joints after each division rhomboidal and closely united laterally. Second brachial bluntly wedge-shaped. Third (syzygy) and four next joints short and oblong. The following ones short, bluntly wedge-shaped, and overlapping rather strongly, so as to give the arms a serrate appearance; becoming more oblong again about the middle of the arm.

First syzygy on third brachial; the next between 19 and 25, then an interval of 7–12 joints, usually 9 or 10, between successive syzygia.

The size of the lower pinnules varies considerably according as

they are on the outer or inner arms of the rays. The first pinnule, which is borne by the second distichal, is moderately long and stout at the base, but tapers rather rapidly. The pinnules on the second joints of the outer arms are both longer and stouter than the distichal pinnule, sometimes very much so; while that on the fourth brachial is equal to or slightly larger than it. The pinnules on the third and fifth joints are both smaller than their fellows on the outside of the arm, and the size decreases to the fourth pair, after which it gradually increases again. On the inner arms of the rays the fourth brachial usually bears the largest pinnule, those on the second and sixth joints being about equal. The distal ends of the cylindrical joints of the large lower pinnules are raised into slight spines.

Disk naked and considerably incised, 10 mm. in diameter.

Colour purple, with whitish bands; sacculi closely set along the pinnule-ambulacra.

Spread probably about 10 centim.

One mutilated specimen from Canton.

Remarks.—The characters of the lower pinnules distinguish this species very readily from other *Antedons* with primary arms of three joints, the axillary with a syzygy, and secondary arms of two joints, the axillary without a syzygy. This section of the genus includes *A. Savignyii* of the Red Sea, and about fifteen other species, four of which are in the Hamburg Museum.

6. *ANTEDON CRENULATA*, n. sp.

Description of an Individual.—Centrodorsal a thick convex disk 5 mm. in diameter, with a single or partially double row of about 20 marginal cirri. These have 30+ joints, of which the sixth is longer than broad and the following ones tolerably equal; the eleventh joint and its successors bear strong, forward projecting dorsal spines, which diminish again after about the 25th joint.

First radials partly visible, with crenulated distal edges; the second trapezoidal, closely united laterally, and rising rather sharply towards the middle of their junction with the pentagonal axillaries, which are about twice their length. Rays very close to one another and divide twice, or sometimes three times. The first division of three joints, the axillary with a syzygy; and the second of two joints, the axillary without a syzygy. The first two joints beyond each axillary form a slight tubercular elevation at the middle line of their junction. First brachials rhomboidal

and closely united laterally ; the second longer and sharply wedge-shaped. Third (syzygy) and five or six following joints short and oblong. The next ones triangular, more than twice as wide as long and overlapping ; gradually becoming smoother and more oblong in the middle and outer parts of the arms.

First syzygy on third brachial ; the next on 12 or 13, then an interval of 7-10 joints between successive syzygia.

Pinnules variable. The distichal pinnule seems to have been less stout than that on the second brachial. The third brachial bears a small pinnule, usually less than half the length of that on the fifth joint. On the outer arms of the rays the fourth, fifth, and sixth joints bear large pinnules like that on the second ; sometimes the fourth, and sometimes the sixth, bears the larger one. The next pair, on the seventh and eighth joints, are smaller again. On the inner arms the fourth joint, like the third, bears a small pinnule ; and the next two pairs are large, the second pair (on 7th & 8th br.) being the larger. Sometimes, however, the only two really large pinnules are those of the sixth and seventh joints, the previous pair being smaller, but not specially so, like the pinnule on the third joint. These long lower pinnules consist of about 25 stout joints, the distal ends of which have forward projecting lateral processes. In the large lower joints these are chiefly limited to the outer side, but they appear on both sides in the later joints. Similar, but less marked, processes are visible on the cylindrical joints of the remaining pinnules, which increase again in size after the fifth pair, but never become as long as the large lower pinnules.

The colour of the skeleton seems to have been white, and the perisome purplish.

One broken specimen from the neighbourhood of Borneo.

Remarks.—The foregoing description is based upon some dried fragments of a moderately large *Antedon* which appears to be new. Besides the three other species belonging to the *Savignyii* group which are described in this communication, I am acquainted with about a dozen more, nearly all of them from the Eastern Seas. But I have been unable to identify any of them with the form under consideration, which is peculiar in the crenulation of its first radials, the shortness of its arm-joints, and the form of the spines on the cirri and pinnules. It is altogether a larger species than *Ant. variipinna*, from which it is readily distinguished by its crenulated first radials, tubercular arm-bases, and smoother

arms, while the inequality in the sizes of the lower pinnules is not of the same character in the two species.

7. *ANTEDON ACUTICIRRA*, n. sp.

Description of an Individual.—Centrodorsal a thick disk with a flat dorsal surface and 15 long tapering cirri in a single marginal row. These may reach 5 centim. in length and consist of 55 smooth joints. The basal ones are broad and the tenth about square, while the following ones diminish in width and thickness, though the length changes but little. The later ones are longer than wide, but not laterally compressed, the cirri tapering gradually to a sharp point. Terminal claw small and but slightly curved, without any trace of an opposing spine.

Calyx variable; some of the first radials are partially visible, and some of the short second radials are partly concealed. These are closely united laterally; the axillaries nearly twice their length, almost triangular, with open distal angles.

26 long and tapering arms of 200+ joints. Some of the rays divide three times. First division of three joints, the axillary with a syzygy; and the second usually of two joints, the axillary not a syzygy. First joints after each axillary closely united laterally, and slightly raised in the middle line of their junction with their successors. First brachials rhomboidal, short, and wide; the second more wedge-shaped. Third (syzygy) and next four or five joints short and oblong; the following ones bluntly wedge-shaped, twice as wide as their longer side, and slightly overlapping; the middle and later joints more oblong and overlapping rather less.

First syzygy on the third brachial, and the next from 9-16; after which the syzygial interval varies from 5-32, usually from 10-15 joints.

The first pinnule, borne by the second distichal, is comparatively small, with keeled and expanded basal joints. That on the second brachial is considerably larger on the outer arms, but remains small on the inner ones; while those of the fourth and sixth brachials increase in size, the latter reaching 25 mm. in length, and consisting of nearly 40 joints. On the inner side of the arm the third brachial bears a small pinnule like the second distichal, and the next two are much larger, the second one approaching the size of its fellow on the preceding (sixth) joint. The following one (on 8th br.) is somewhat smaller again, though still long; and the next pair are a good deal shorter than their

immediate predecessors, though somewhat larger and stouter than that on the second brachial. Where no distichals are present, but the radial axillaries bear arms directly, the fourth pair of pinnules are large like their immediate predecessors. The size decreases to about the fifteenth joint, and then increases very slowly again, the outer pinnules only reaching about one third the length of the largest lower pinnules, which have wide and strongly keeled basal joints. On the smaller pinnules after the fifth pair this carination is less marked, but it is traceable for some little way out on to the arms.

Disk naked and considerably incised, 15 mm. in diameter.

Colour nearly white, with traces of a deep violet remaining. Sacculi very close along the pinnule-ambulacra.

Spread about 25 centim. One specimen *sine patria*.

Remarks.—This fine species differs from all but two of those in the *Savignyii* group in the great length of its cirri, which are only exceeded by those of *Ant. Eschrichtii*, *Ant. phalangium*, &c.; and, despite their length, they are remarkable for being in a comparatively undeveloped condition. The terminal claw is very small and but slightly curved, without any trace of an opposing spine, which is just the condition of the immature cirri of other species.

There is an *Antedon* from Sydney in the University Museum at Copenhagen, bearing the MS. name of *Ant. australis*, Lütke, which has some resemblance to *Ant. acuticirra*. With the same arrangement of the ray-divisions, it has a few long and many-jointed cirri and a large third pair of pinnules; but it has relatively shorter axillaries and a shorter syzygial interval, usually 6–8 joints instead of 10–15. Without a more detailed examination of the Copenhagen specimen than I have as yet been able to make, it is difficult to be certain as to its identity with the one which I have described above as *Ant. acuticirra*.

8. *ANTEDON LUDOVICI*, n. sp.

Description of an Individual.—Centrodorsal a thick disk with a flattened dorsal surface and a single or partially double row of 25 marginal cirri. These have from 40–50 tolerably equal joints, all of which, except those at the extreme end, are wider than long. Even in these terminal ones the length is but little greater than the width, and there is a slight tubercle in the middle of the dorsal surface, which is most marked on the penultimate joint.

First radials partially visible; the second short, widely oblong, almost completely united laterally, and slightly raised in the

middle of their junction with the axillaries. These are one and a half times as long as the preceding joints, widely pentagonal, with open distal angles, and also slightly raised in the middle of the hinder edge.

30 arms, each of 150+ joints. The rays may divide three times: the first division of three joints, the axillary with a syzygy; and the second of two joints, the axillary without a syzygy. The first joints after each axillary rhomboidal and closely united laterally, with the distal edge very slightly incised to receive the convex hinder edge of the next joint. Third brachial a syzygy, short and oblong. The next four or five joints also short, with somewhat oblique terminal faces, and slight backward projections alternately on the inner and outer sides. The fourth and sixth joints are thus longer on their inner sides, and the fifth and seventh on their outer ones. Following joints short, bluntly wedge-shaped and overlapping, nearly twice as wide as long, and becoming more oblong about the middle of the arm.

First syzygy on the third brachial; the next from 8-16, usually on 12; then an interval of 7-14, usually 9 or 10, joints between successive syzygia.

First pinnule on the second distichal, quite small, little more than half as long as and far more slender than those on the second and third brachials, which are about equal. The next pair are still larger, and the third pair (on 6th & 7th br.) still more so, consisting of about 35 stout joints and reaching nearly 35 mm. in length. That on the seventh joint is rather the smaller and the next pair considerably so, only about equal to the first pair. The diminution continues to about the seventh pair, which are not specially small, being scarcely less than 10 mm. long. The remaining pinnules are of about the same length, but gradually become more slender. The basal joints of the lower pinnules from the distichal pinnule onwards have rather sharp dorsal keels. These may be less marked on the stout joints of the pinnules of the second and third pairs, but reappear on the second and four following joints in the fourth pair, and then gradually decrease in distinctness, disappearing altogether by about the 25th joint.

Disk naked and considerably incised, 15 mm. in diameter.

Colour light brown. Sacculi closely set along the pinnule-ambulacra. Spread 20 centim.

One specimen from Hong Kong.

Remarks.—I have named this fine species after my friend Prof.

H. Ludwig, of Giessen, who is so well known by his important researches in Echinoderm morphology. Like *Antedon acuticirra* it has a large number of cirrus-joints, but they are relatively shorter and wider, so that the cirri do not reach more than 3 centim. in length, and taper less than the longer cirri of that species do; while the later ones develop dorsal tubercles, which are altogether wanting in the longer terminal joints of *Ant. acuticirra*. The form of the cirrus-joints distinguishes *Ant. Ludovici* from the *Ant. australis*, Lützk., already referred to, which it resembles in the syzygial intervals and in the relative sizes of the third and fourth pairs of pinnules, though the lower joints of the latter are less strongly keeled in the Copenhagen specimen than in *Ant. Ludovici*. The single specimen of this last species in the Hamburg Museum has two or three of the pinnules very much enlarged and unnaturally overgrown. In one case the malformation is connected with the development of a large cyst on the ventral perisome of the arm, which is protected by a coating of polygonal plates, and is most probably the home of a parasitic *Myzostoma*.

9. ANTEDON BIPARTIPINNA, n. sp.

Description of an Individual.—Centrodorsal a thick, slightly convex disk, bearing a single marginal row of 14 long and stout cirri. These may reach almost 6 centim. in length, and consist of nearly 60 joints. The basal joints are very wide, nearly 2 mm. the 15th and following ones about square, and the terminal joints slightly longer than wide, quite smooth, with a very imperfectly formed claw and no trace of an opposing spine.

First radials partially visible at the angles of the calyx; the second shorter in the middle line than at their sides, where they are closely united to their fellows. Both they and the short, almost triangular axillaries rise to a slight tubercular elevation in the middle line of their junction.

35 arms of 200+ joints. The rays in close contact, but dividing three times. First division of three joints, the axillary with a syzygy; the second usually the same, but sometimes of two joints, the axillary without a syzygy. The first joints after each axillary are rhomboidal and closely united laterally, and the second more wedge-shaped, the middle of their junction being tubercular like that of the two outer radials. Third brachial (syzygy) and the next four or five joints oblong; the following ones short, sharply wedge-shaped and very slightly overlapping, twice as wide as long.

About the middle of the arm they become more equal-sided, and are nearly oblong in the terminal portions.

First syzygium on the third brachial, and the next from 11–15; then an interval of 6–12, usually 8 or 9, joints between successive syzygia.

First pinnule on the second distichal, quite short; but the next three on the outside of the arm (on 2nd palm., 2nd & 4th br.) are rather longer. They all have somewhat the appearance of being in two parts, as if they had been broken and regenerated. The lower half consists of wide and thick joints with dorsal keels; while the upper half is composed of quite small joints, and grows, as it were, out of the middle of the wide lower portion. This is least marked in the pinnule on the fourth brachial, which is nearly twice as long as that on the second joint, stouter, and more uniformly tapering. The next (on 6th br.) is still longer, reaching 25 mm., and consists of about 50 broad joints, the lower ones of which are keeled; the following one (on 8th br.) is nearly as long, but less stout. On the inner side of the arm the seventh joint bears a large pinnule like the preceding one. That on the fifth joint is much smaller, and that on the ninth variable, sometimes small and sometimes nearly as large as its fellow of the fourth pair. In some arms the fourth or eighth joint may bear the largest pinnule. Beyond the fourth pair the length decreases, rapidly at first, but afterwards more gradually till about the 20th joint, beyond which the pinnules are tolerably uniform in size, decreasing again towards the arm-ends. The carination of the basal joints of the lower pinnules dies away gradually, and is lost after the tenth pair.

Disk naked and much incised, 15 mm. in diameter. Colour deep purple, almost black. Sacculi closely set along the pinnule-ambulacra.

Spread nearly 25 centim.

One specimen from Hongkong.

Remarks.—This is one of the very few species of *Antedon* which have three joints in the secondary as well as in the primary arms. I know of but seven species belonging to this section of the genus, in three of which the rays divide a fourth or even a fifth time. Apart from this character, they are altogether different from the species under consideration, which comes nearest to *Antedon Philiberti*, Müll. sp., from Java. It differs, however, in the peculiar shape of the lowest pinnules, and in the undeveloped condition of the terminal cirrus-joints, none of which, even the penultimate, bear dorsal spines.

Genus *ACTINOMETRA*, Müll.

A. Second and third radials united by syzygy.

Ten arms, very wide at the base.

- a. Lower joints of the pinnules on the third and some of the following brachials have expanded keels. 1. *solaris*, Lam.
- b. Lower joints of second and third pairs of pinnules not keeled. Arm-bases tubercular. 2. *robusta*, Lützk.

B. Second and third radials united by ligament.

Rays divide from 2-5 times. The first division of three joints, the axillary with a syzygy.

- a. Only two ray-divisions 3. *parvicirra*, Müll.
- b. Second division of two joints, the axillary with a syzygy. Third division like the first. 4. *grandicalyx*.
- c. Second and third divisions of two joints, the axillary with a syzygy . . 5. *multiradiata*, Linn.
- d. Second division like the first. No further division 6. *Meyeri*, n. sp.
- e. Second and subsequent divisions all like the first. 7. *Bennetti*, Mus. Leyd.

1. *ACTINOMETRA SOLARIS*, Lam., sp.*

Description of an Individual.—Centrodorsal a thin pentagonal disk, bearing two cirri at each angle. These have 22 or 23 joints, the fourth of which is about square; the remainder tolerably equal and longer than broad, the penultimate having a well-marked spine.

Three radials visible; the second trapezoidal, closely united laterally and widest along the distal edge, where they are united by syzygy to the triangular axillaries, which are more than twice their length.

Ten arms of 130+ joints, and only slightly increasing in width from the base. First two brachials joined by syzygy; the lowest one closely united to its fellow, shorter on the inner than on the outer side, which is only two thirds of the width. The next five or six joints more oblong, with their junctions slightly raised alternately on the inner and outer sides. Succeeding joints triangular, with convex proximal and concave distal edges, half as long as wide (nearly 5 mm.), and becoming more quadrate towards the arm-ends. The lower and middle parts of the arms have a faint, slightly raised, medio-dorsal line.

*The literature of this species will be found on p. 192 of 'Notes from the Leyden Museum,' vol. iii.

A syzygy in the third brachials*, and another about the eleventh joint; then an interval of 3-5 joints between successive syzygia.

The first pair of pinnules are borne by the epizygals of the two lowest syzygial joints. They are about equal in length (20 mm.), and consist of about 40 joints, the lowest five or six of which are wide and stout, with prominent dorsal edges but no distinct keels. The next two pinnules on either side are of decreasing length and stoutness, the second and third joints being wide, with strong and expanded dorsal keels. The fourth pair, though somewhat shorter than the third, are considerably stouter, with wider and more massive joints and large genital glands. The following ones somewhat longer and tolerably equal, decreasing again after about the 25th joint, but remaining stiff throughout and never becoming specially slender. The lower and middle joints of these pinnules, till far out on the arms, are very wide (reaching nearly 2 mm.), with sharpened dorsal edges. The middle joints of the pinnules do not become elongated till about the 80th arm-joint. Terminal comb limited to the first three pairs.

Disk naked, 15 mm. in diameter, with a radial mouth. Colour brownish white, with a broad reddish-brown band on either side of a narrow lighter one in the median line of each arm.

Spread about 30 centim.

One specimen from Hongkong.

Remarks.—The fine specimen described above is one of many variations on the type of *Comatula solaris*, Lam., one of the species for which the genus *Actinometra* was originally created by Müller. Lamarck's examples were obtained in the Australian seas during the voyage of Peron and Lesueur (1803); and they were subsequently examined by Müller, whose description of them is

* In this species and its allies the two outer radials and the two lower brachials are united by syzygy, so that the true third brachial appears to be the second. This joint itself is primitively double, consisting of the original third and fourth brachials, which are united by syzygy, the pinnule on the third joint remaining undeveloped. There are very few *Comatulæ* (e. g. *Actinometra multiradiata*) in which this is not the case; and it is therefore convenient to speak of the third brachial as a syzygial or double joint. But the rare syzygial union of the first two brachials, as in *Act. solaris*, is of a different morphological value altogether; and it is therefore better for the purposes of description to consider them as really two joints, rather than as forming a single compound one. In most *Comatulæ* they are united by a ligamentous articulation, which has often been wrongly spoken of as a syzygy.

quite one of the best of any that he wrote. The large specimen in the Vienna Museum, which was described by Müller as *Actinometra imperialis**, was eventually referred by him to Lamarck's type†. Both forms agree in their general characters, as I have been enabled to determine by personal examination of their fragmentary remains—a privilege for which I am much indebted to Dr. Steindachner and Prof. Perrier. The peculiar features of the species are the characters of the lower pinnules. The first pair are composed of numerous stout joints, the lowest of which are stouter than, but not otherwise different from, their successors. But in the next pair of pinnules some of the lower joints have their dorsal edges produced into well-marked keels. In Lamarck's type these keels occur on the second, third, and fourth joints of the pinnules on the third and fourth brachials; while in the Vienna specimen there is little or no keel on the fourth joint of the fourth pinnule, and in the Hamburg one described above the third pair of pinnules have keels on their second and third joints. I do not, however, regard this variation as of any importance, though I think that the entire absence of any keel on the two lowest pinnules is a good distinctive character of the type. Other points in which the Paris, Vienna, and Hamburg specimens all agree are the unusual size of the lower arm-joints, which may be as much as 5 mm. wide, and also the shape of the joints composing the pinnules of the sixth and following pairs. These are best seen when the pinnules are dried, as they are then less concealed by perisome. The lowest joints are more than twice as wide as long; and though this disproportion gradually decreases, it is only quite at the extreme end of the pinnule that the joints become any thing like square. This peculiarity is, of course, most marked in the lower pinnules; but it is not until well on into the second third of the arm that the middle joints of the pinnules begin to be at all longer than broad.

What therefore may be called the special marks of *Act. solaris* are as follows:—10–15 cirri of 20–24 joints; arm- and pinnule-joints very wide; expanded keels on the lower joints of the second pair and some of the following pinnules, but the basal joints of the first pair are not keeled.

Closely related to this large type are several others of smaller size, and with fewer joints in the cirri, for which it is difficult as

* Wiegmann's Archiv, 1841, i. p. 141.

† Abhandl. d. Berlin. Akad. 1849, p. 248.

yet to determine the range of variation. Such are the specimens brought by Professor Semper from Bohol, and formerly referred to by myself as *Act. solaris**. These have keels on the basal joints of the pinnules borne by the *second* and following brachials, and much less massive arm- and pinnule-joints. The *Asterias pectinata*, Linn.†, has traces of keels on the basal joints of both the first pinnules, while those of the next pair are strongly keeled. In a couple of small specimens from the voyage of Peron and Lesueur, which I found in the Paris Museum, the pinnules on the second and fourth brachials have keeled lower joints, but there is hardly any trace of this in the third pinnule; while in *Actinometra affinis*, Lütke. MS., from Java (Copenhagen Museum), the first three pinnules have strong keels, and there are lesser ones on the next pair. The Müllerian types *Comatula purpurea*, *C. brachiolata*, and *C. rosea* all belong to this "*solaris* group." In the first named, only the third pinnule has any keeled joints. The other two species were regarded by Müller as possibly identical, a view in which I entirely concur. In this type, which will therefore have to be known as *Actinometra rosea*, the basal joints of the first six pinnules are not specially marked, while the arm-bases have tubercles at the junction of the joints, alternately on the inner and outer sides.

It will be a matter of no little difficulty to determine the exact mutual relations of these various forms, which all agree with *Act. solaris* in the syzygial union of the two outer radials. The greater part of them are unfortunately dry and in a very fragmentary condition, as are Müller's original specimens of *Act. solaris*, on which account I have thought it desirable to redescribe the type from the fine spirit-specimen in the Hamburg Museum.

2. ACTINOMETRA ROBUSTA, Lütken, MS.

Centrodorsal a low flattened disk 7 mm. wide, bearing a single or partially double row of 20–25 marginal cirri. These have about 23 joints, of which the first three or four are wider than long, and the following ones about square, or a trifle longer than wide, decreasing slightly towards the end; the penultimate has a small opposing spine.

Three radials visible; the second short, trapezoidal, closely united laterally, and united by syzygy at their wider distal edges to the triangular axillaries, which are twice their length.

* Trans. Linn. Soc., 2nd ser., Zool. vol. ii. pp. 62 *seq.*

† 'Systema Naturæ,' ed. x. tom. ii. p. 663.

Ten arms of 200 joints, rather more than 3 mm. wide at the third brachial, but increasing to 5 mm. by the twelfth joint, remaining uniform to a short distance, and then tapering to the ends.

First two brachials united by syzygy, and together twice as wide as their outer side, which is slightly the longer, though the hypozygal (on 1st br.) is longer at its inner side, which is very closely united to its fellow. Epizygal (on 2nd br.) acutely triangular, with curved sides, half as long as broad. Third brachial a syzygy, roughly oblong, with a somewhat raised forward projection from the inner part of its distal edge; and the fourth brachial has a corresponding elevation at the inner side of its proximal edge, so as to give a somewhat tubercular appearance to the line of junction. The same feature is visible on the outer part of the line of junction between the nearly oblong fourth and fifth brachials, and recurs alternately on opposite sides of the arm for a few joints further. As the joints become flatter and more triangular, with curved edges, it gradually disappears. They are rather more than half as long as wide, with a very faint, slightly raised median line, and retain the triangular shape and curved edges as far as the 160th joint, narrowing and becoming blunter at the extreme ends of the arms.

Syzygia on the third and tenth brachials; then an interval of 3-6, usually 4 or 5, joints between successive syzygia, the hypozygals being very short.

The first pair of pinnules borne on the epizygals of the two lowest syzygial joints are long (25 mm.), and moderately stout, consisting of about 60 joints, of which the first three or four are nearly square. The following ones are shorter and more oblong, and gradually decrease in width, the outer edges of the last 30 bearing the strong lancet-shaped processes forming the terminal comb. The second pair of pinnules are smaller with fewer joints, only the first two of which are about square, while they have no dorsal keels. They also have a well-marked terminal comb; but this appears to be wanting on the pinnules of the third pair, which are still smaller, with short and wide triangular basal joints. The fourth pair as long or longer than the third, but stouter, with wider and more massive joints. The following pinnules increase in both length and stoutness, consisting of about 30 joints, the first half of which are about twice as wide (2 mm.) as long, with sharpened dorsal edges which are sometimes pro-

duced into slight keels. The largest pinnules are those between the 10th and 25th brachials, and a little further on they become more slender, with squarer joints, the terminal pinnules having somewhat elongated joints.

Disk 25 mm. wide, without any trace of calcareous deposits. Colour of dry specimen black. Spread probably about 25 centim.

One specimen from Australia.

Remarks.—The above description is based upon a couple of dry specimens, one of which is in the Hamburg Museum, and the other now in the possession of Dr. Carpenter; they were both purchased originally from the Messrs. Godeffroy, for whom the type had been named by Dr. Chr. Lütken, of Copenhagen; but he has published no description of it, and informs me that he does not intend to do so, being now occupied with another branch of zoology. Specimens of the type, bearing his MS. name, occur in a good many museums; and I have therefore thought it undesirable to rename it.

Act. robusta has a considerable resemblance in general appearance to *Act. solaris*, both species having large arms composed of massive triangular joints with curved edges, and stout pinnules of broad joints. The arm-bases of *Act. solaris*, however, are nearly or quite smooth, and have little tendency to alternate tubercular elevations such as are visible in *Act. robusta*; in the latter species, too, the width of the arms increases more distinctly in the first few joints than in *Act. solaris*, while the second and third pairs of pinnules have no expanded keels on their lower joints such as appear in *Act. solaris*, and the cirri are larger and more numerous.

3. *ACTINOMETRA PARVICIRRA*, Müll., sp.*

Two specimens of a small *Actinometra* from Peru must, I think, be referred to this species. I can find no characters by which I can separate them from any one of its various forms that inhabit the Eastern seas. One of them is very small, and has lost its disk, but the other is larger and more perfect, though wanting some of its arms. The mouth is not quite so distinctly inter-radial as in the Philippine specimens, which I have described† as *Act. polymorpha*, but there is the same dimorphism of the arms. All are grooved, but the grooves on the posterior arms are much

* The literature of this species will be found on p. 204 of 'Notes from the Leyden Museum,' vol. iii.

† Trans. Linn. Soc. 2nd ser. Zool. vol. ii. pp. 29-53.

smaller and less distinct than on the anterior arms, and do not extend on to the pinnules. Some of these hinder arms consist of less than fifty joints, while in the anterior arms there are more than a hundred. The terminal ungrooved pinnules of the former are also thicker and more clothed with perisome than those at the same distance from the calyx on the anterior arms. But I can find no trace in any of them of any of the ovoid bodies which I have observed in some of the Philippine specimens *, and in a few other species †.

4. ACTINOMETRA GRANDICALYX, n. sp.

Description of an Individual.—Centrodorsal large and hemispherical, 10 mm. wide, with the dorsal pole free from cirri and somewhat hollowed. About 50 cirri of 23–26 moderately stout joints, the fourth of which is about square, and the 8th–10th the longest. The following ones decrease in size, and the terminal joints develop blunt dorsal tubercles, that on the penultimate being the most distinct.

Second radials partially concealed; axillaries relatively long, almost triangular, with sharp distal angles.

47+ arms, some of the rays dividing four times. The first and third divisions each of three joints, the axillary with a syzygy; the second division of two joints, the axillary without a syzygy. The first joints after each axillary closely united laterally, and bluntly wedge-shaped, the outer sides being the longer. Second brachials somewhat shorter and more oblong than the first. The third (syzygy) and the next three or four joints also nearly oblong; the following ones overlapping and rather sharply wedge-shaped, nearly twice as wide as long, becoming shorter and blunter after about the 30th joint.

First syzygium on the third brachial and the next from 13–20; then an interval of 3–9, usually 3 or 4, joints between successive syzygia.

The first pinnule (borne by the second distichal) slender, except just at the base, and very long, reaching almost 25 mm. The next one on the second joint of the tertiary arm (when present) is somewhat shorter, and that on the second brachial more so, though still more than 15 mm. long. This pinnule is longer when there are no tertiary arms.

The following ones decrease to those of the 7th and 8th joints,

* Trans. Linn. Soc. 2nd ser. Zool. vol. ii. p. 40, pl. ii. fig. 6.

† Bull. Mus. Comp. Zool. vol. ix. no. 4, pp. 11, 12.

which are not specially small. The succeeding pinnules gradually increase in length, and are also stouter with larger joints, becoming more slender again when the arm-joints decrease in size. The second and third joints of the pinnules borne by the third and five or six following brachials have slight dorsal projections, which are much more distinct on some arms than on others.

The lowest pinnules have a tolerably well-marked comb, which gradually decreases in size, and ceases after the 7th or 8th joint.

Disk naked, 30 mm. in diameter. Mouth radial, and all the arms grooved.

Perisome blackish brown; the skeleton somewhat redder, with a broad white stripe along the medio-dorsal line, which starts from the centrodorsal, and extends outwards on to the arms. Spread about 20 centim.

One specimen from Canton.

Remarks.—I know of only one other *Actinometra* with the same number and arrangement of the arm-divisions as in this type. It was obtained by the 'Challenger' at Banda, and is a much smaller specimen, with a thin flat centrodorsal. There are other species, such as *A. alternans* of the Leyden Museum, with five arm-divisions, the first four of which resemble those of *A. grandicalyx*; and there are about half a dozen species with three distichals and two palmars, as in most of the rays of the latter type. But the large size of its centrodorsal distinguishes it from all of these. I do not know of any other *Actinometra*, except *A. Bennetti*, which has so many cirri and so large a centrodorsal, which is nearly half as wide again as that of *A. robusta*.

5. ACTINOMETRA MULTIRADIATA, Linn., sp.

1758. *Asterias multiradiata*, Linnæus, *Systema Naturæ*, ed. 10, tom. ii. p. 663.

1783. *Asterias multiradiata*, Retzius, *Kongl. Vetenskaps Academiens Nya Handlingar* (Stockholm, 1783), tom. iii. p. 241.

1788. *Asterias multiradiata*, Linnæus, *Systema Naturæ*, ed. 13, pars vi. p. 3166.

1805. *Asterias multiradiata*, Bruzelius, *Dissertatio sistens species cognitas Asteriarum** (Lundæ, 1805).

1816. *Comatula multiradiata*, Lamarck, *Syst. d'Anim. sans Vert.* ii. p. 534.

1834. *Comatula multiradiata*, De Blainville, *Manuel d'Actinologie*, p. 249.

* There can, I think, be little doubt that Prof. Jeffrey Bell is right in ascribing this dissertation to Bruzelius (*Ann. & Mag. Nat. Hist.*, March 1882, p. 166).

1843. *Comatula* (Alecto) *multiradiata*, Müller (pars), *Wiegmann's Archiv*, 1843, i. p. 133.

1849. *Comatula* (Alecto) *multiradiata*, Müller (pars), *Abhandl. d. Berlin. Akad.* 1849, p. 261.

1862. *Actinometra multiradiata*, Dujardin (pars), *Hist. Nat. des Zoophytes, Echinodermes*, p. 210.

1879. *Actinometra multiradiata*; P. H. Carpenter, *Trans. Linn. Soc. Zool.* 2nd ser. vol. ii. p. 27.

The museum contains some fragments of a dried example of this species from Sumatra; but they are too imperfect to serve as a basis for a redescription of the type.

So far as I can make out, Linnæus's original description* of *Asterias multiradiata* was based upon a specimen from the Indian seas which is now in the Retzian collection of the University Museum at Lund. It was as follows:—"*Asterias radiata* radiis palmato multiplicatis pinnatis: inferioribus filiformibus." To this type Linnæus referred the *Caput Medusæ cinereum* and *C. brunnum* of Linck†. Retzius, twenty-five years later, gave a somewhat longer description‡ of the species, to which, like Linnæus, he referred the two specimens figured by Linck. Bruzelius, in the dissertation§ which has been lately attributed to his pen by Prof. F. J. Bell, repeated the descriptions of Linnæus and Retzius, the latter with slight modifications; but he expressed a doubt as to whether Linck's *C. brunnum* belonged to this type. This doubt seems to me fully justified; for, so far as I can judge from Linck's figures, *C. brunnum* is an *Antedon*, while *C. cinereum* is an *Actinometra*, though not identical with the type specimen of *Asterias multiradiata*. Lamarck|| merely repeated the Linnæan name and reference to Linck, with the remark that the species might have fifty or sixty arms: but he did not refer any of the specimens collected during Peron's voyage to this type. This, however, was subsequently done by Müller¶, who had personally examined the Retzian specimen at Lund. It belongs to a rather small section of the genus (*Actinometra*) in which there are three joints in the first division of the rays, but only two in

* 'Systema Naturæ,' ed. 10, tom. ii. p. 663.

† 'De Stellis Marinis liber singularis' (Lipsiæ, 1783), p. 55, tab. xxi. n. 33, tab. xxii. n. 34.

‡ 'Kongl. Vetenskaps Academiens Nya Handlingar' (Stockholm, 1783) tom. iii. p. 241.

§ 'Dissertatio sistens species cognitatas Asteriarum,' Lundæ, 1805.

|| 'Syst. d'Anim. sans Vert.' ii. p. 534.

¶ 'Abhandl. d. Berlin. Akad.' 1849, p. 261.

the second and subsequent divisions, while all the axillaries are syzygial or double joints.

Müller does not seem to have regarded the number of joints in the successive ray-divisions as of specific value; and he grouped under the same specific name as that of the Linnæan type some *Comatulæ* in the Bonn and Paris Museums, the latter from the voyage of Peron and Lesueur. These have three joints in the second and third ray-divisions as well as in the first; and I have accordingly removed them from the type of *Actinometra multiradiata*, and have described them under the name of *A. Peronii**.

There is, however, a dry specimen from Peron's voyage in the Paris Museum which does agree with the Linnæan type; and it was referred to this by Müller, along with a fine spirit-specimen of *A. Peronii* from the same voyage, and two others brought by Quoy and Gaimard from the Moluccas. One of these last is *A. Peronii*, and the other *A. multiradiata* in the restricted sense.

Two individuals of this species were dredged by the 'Challenger' at Banda; and I have thought it desirable, for the sake of other workers, to redescribe the type from them and from my notes of Quoy and Gaimard's example just referred to. The Linnæan specimen and that from Peron's voyage in the Paris Museum are dry and reduced to many fragments. For the privilege of examining them I am indebted to the kindness of Professors Quennerstedt and Lundgren, and of Prof. E. Perrier.

ACTINOMETRA MULTIRADIATA, Linn., sp.†

Centrodorsal a thick disk, sometimes almost columnar, with the dorsal pole hollowed, and bearing a single or partially double row of 20-30 moderately stout marginal cirri. They may have 30-40 joints, of which the fifth is usually longer than wide and the next two or three the longest, least markedly so in the older specimen. The next few joints shorten rather rapidly, and commence to overlap on the dorsal side. This is most marked in the following joints, which are nearly square and somewhat compressed laterally. Small spines gradually appear near their distal edges, and increase in distinctness up to the penultimate joint.

First radials just visible, least so in the larger specimen; the second relatively long, more or less hexagonal, and partly united laterally. Axillaries pentagonal, about twice their length. The rays and their subdivisions are well separated from one another.

* 'Notes from the Leyden Museum,' vol. iii. pp. 214-217.

† Published by permission of the Lords Commissioners of the Treasury.

They may divide four times: the first division of three joints, the axillary with a syzygy; the second and subsequent ones of *two* joints, the axillary also with a syzygy. The first distichals are nearly oblong; but the first palmars are more wedge-shaped and longer in proportion to their width.

40-60 arms of 120-150 joints. First brachials tolerably oblong, or slightly unequal-sided; the second (syzygy) and next few joints oblong. The following ones almost triangular, with overlapping coarsely spinous distal edges, which are not very oblique, as the joints are relatively short and only half as long as broad. From about the fortieth onwards the joints become more oblong as the arms narrow, and the terminal ones are squarer. The anterior arms may be slightly the longer.

First syzygium on the second brachial; the next from 15-30, usually about 20. Then an interval of 4-8, usually 5 or 6, joints between successive syzygia.

The second distichals bear long pinnules (nearly 30 mm.), which are moderately stout at the base, but soon become more slender. The next ones are on the first joints after each axillary; and the length decreases to the pinnules of the fifth and sixth brachials, which are not specially small. The following ones slowly increase again, but not to any great extent; so that the terminal pinnules are not unusually long. The last 12 or 15 joints of the lowest pinnules bear a terminal comb, which may extend out to about the 15th arm-joint; and the edges of the pinnule-joints are fringed with spines.

Mouth radial, or nearly so. Disk 15 mm. in diameter, may be naked, or have a few calcareous nodules on it.

Colour blackish brown. Spread 25 centim.

Two specimens from Banda.

Remarks.—In the smaller specimen the first radials are more completely visible, and the distal edges of the distichal and palmar joints are smooth; but in the larger the first radials are hardly visible, and the distichal and palmar joints have slightly raised distal edges, with a tendency to the same coarsely spinous character that appears on the arm-joints. In the smaller specimen, too, the cirri are longer, and have more numerous joints, the number reaching 35 or 40; while in the larger individual it falls to 26.

In Quoy and Gaimard's specimen the distichal and palmar pinnules have a slight keel on the second and third joints, traces

of which sometimes extend out on to the arms as far as the 7th joint. But it does not occur in the 'Challenger' specimens.

In the dry specimen from Peron's voyage there is a tolerably well-marked median tubercle at the junction of the first and second distichals, of which there is hardly any trace in the other examples; while the syzygial interval appears to be 10-13 joints.

In the original example at Lund the centrodorsal partly conceals the second radials, which are closely united laterally, and the axillaries are more triangular; while the position of the second syzygy may be from the 20th to the 39th brachial.

The mutilated specimen from Sumatra belonging to the Hamburg Museum resembles the larger of the two 'Challenger' individuals in the more complete concealment of the first radials, and in the small number of cirrus-joints, which may be reduced to 23. The second syzygy also may be as early as the 11th brachial, while the later syzygial interval may rise to over 20 joints.

There are about six other species of *Actinometra* which resemble *A. multiradiata* in the number and arrangement of the ray-divisions; but the large size of its centrodorsal, the overlap of its arm-joints, and the fringe of spines on them and on the pinnule-joints are sufficient to distinguish it from them.

6. *ACTINOMETRA MEYERI*, n. sp.

This is rather a large species from Australia, distinguished by the thin centrodorsal and the small number of cirri which it bears. The rays divide three times, each division consisting of three joints, the axillary with a syzygy. The arm-joints are triangular, and overlap rather markedly. The lowest pinnules appear to have been long and slender; but in the dry specimen it is difficult to make out their relative proportions, a point of much importance for specific determinations. The museums at Dresden and Vienna contain some individuals in spirit which are probably identical with the dry Hamburg specimen, so far as I can judge from my notes, without having made a direct comparison; and I prefer therefore to reserve a detailed description of the type until I have made a closer examination of the spirit-specimens. I propose to name it after Dr. A. B. Meyer, the accomplished Director of the Zoological Museum at Dresden, who collected some fine individuals during his residence in the Philippine Islands.

7. *ACTINOMETRA BENNETTI*, *Mus. Leyd.* sp.*

The Hamburg Museum contains two examples of this fine species, which differ in points of detail from the somewhat mutilated type specimens in the Leyden Museum. One of them, which was obtained at Singapore, a new locality for the type, is remarkably perfect; while the other (*sine patria*) is considerably mutilated, nothing remaining but the calyx, arm-bases, and disk. As in the type specimens, the mouth of this individual is nearly radial, though not absolutely so; while it is absolutely inter-radial in that from Singapore. I find that variations of this kind are not uncommon in species with very numerous arms, and that the position of the mouth relatively to the rays is far less constant than in the simpler forms with 10-10 arms.

The centrodorsal reaches 12 mm. in diameter; and in both individuals the cirri are much longer and stouter than in the type. Some of them reach 35 mm. in length, and consist of the same number of joints, 8 or 10 more than in the type; while the basal joints are very broad, and there are few, if any, that are at all longer than broad. The calyx and ray-divisions are of the same nature as in the type, each division of three joints, the axillary with a syzygy. In the Singapore specimen the surface of the joints is smooth and even; but in the other their edges are slightly raised and somewhat spiny. In both individuals the fourth and following brachials are almost devoid of the alternating backward projections which are visible in the corresponding joints of the type specimens; but some arms of the Singapore form have slight tubercles in the same positions. Its remaining arm-joints are essentially similar to those of the type specimens, except that they are somewhat wider relatively to their length, while the second syzygy is rather further from the calyx; though I have not found it as far out as the 38th joint, as in the individual examined by Böhlische.

Both specimens are remarkable for the great length of their lowest pinnules, which may reach 40 mm., but are relatively slender, none of their joints, except the broad basal ones, being specially stout. These lower pinnules, and in fact the whole arms, of the Singapore individual are much more clothed with perisome than are those of the type specimens at Leyden.

* The literature of this species will be found on p. 212 of 'Notes from the Leyden Museum,' vol. iii
